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ABSTRACT

One of twelve water treatment technology units, this student manual on cross connections provides instructional materials for two competencies. (The twelve units are designed for a continuing education training course for public water supply operators.) The competencies focus on cross connections terminology and control devices. For each competency, student objectives, resources (information sheets, references to manuals, and appendix materials), learning activities, and evaluation activities are provided. The appendices contain information sheets on cross connections, public health significance of cross connections, cross connections and backflow prevention regulations, and required backflow prevention devices. Evaluation forms with answer keys are provided for each competency. (JH)

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Water Treatment Technology

CROSS-CONNECTIONS

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Huntington, West Virginia

December, 1978

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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CE 022 316

CROSS-CONNECTIONS

EVALUATOR'S COPY

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EVALUATOR'S INSTRUCTIONS

Name _____

Address _____

_____

Phone _____

This is your EVALUATOR'S COPY of the CROSS-CONNECTIONS unit. It contains all of the materials received by the operators who will be working on the unit. It also contains *answer keys* and *directions* for the evaluation of each Competency. For each Competency Sheet, there is a COMPETENCY, a list of RESOURCES, LEARNING ACTIVITIES, and EVALUATION ACTIVITIES.

Your student operators will call you when they are ready to be evaluated. An operator may complete the evaluations in *any* order. S/he may choose to complete one at a time, or several at one time. *It is up to you and each operator to set convenient schedules for the evaluations.* It is important that the operators learn the skills listed in each competency. It is <u>your</u> job to be sure the operators can perform the competencies.

If an operator does <u>not</u> complete an evaluation correctly, s/he may try again later after practicing the skills. It would be helpful for you to tell the operators just how thay should improve their knowledge and skills in order to complete the evaluation successfully. Be sure to call if you have any questions.

This package contains:

- - - - - CROSS-CONNECTIONS unit

- - - - - Evaluation Forms for each Competency

You will receive instructions as to where to send the completed evaluation forms. Please be sure that the operator's name and your name are on the forms, as well as the date on which the evaluation was performed.

INSTRUCTIONS FOR THE STUDENT OPERATOR

The CROSS-CONNECTIONS unit contains two competencies. A "competency" is a skill that is necessary for good on-the-job performance. Each competency in this unit is necessary for you to perform on the job according to the West Virginia Department of Health. There is a Competency Sheet to help you understand each competency.

DIRECTIONS FOR COMPLETING THE UNIT:

1. Read each Competency Sheet carefully. Every Competency Sheet contains:

   COMPETENCY
   Objectives
   RESOURCES
   LEARNING ACTIVITIES
   EVALUATION ACTIVITY(IES)

2. After reading the whole Competency Sheet, you should understand what will be expected of you.

3. Do the LEARNING ACTIVITIES that you think will help you the most. This may include reading some of the RESOURCES which have been included with the unit.

4. If you need additional help, ask an operator in your plant for assistance, or call your evaluator; he's there to help you.

5. When you are ready to complete the EVALUATION ACTIVITY for one or more competencies - - call your evaluator. The two of you will schedule the best time for your evaluation.

   a. If you complete the evaluation correctly, go on to the next competency.
   b. If you do <u>not</u> complete the evaluation correctly, your evaluator will tell you what your mistakes were. You must go back and practice your skills and read the RESOURCES again. Call your evaluator when you are ready to try again. *You must wait at least one week before being re-evaluated on a competency.*

SEE NEXT PAGE

6. When you complete all your evaluations correctly you will receive a Certificate of Accomplishment and 0.4 Continuing Education Units of Credit.

7. If you want to go on to another unit, contact your evaluator for the materials. The procedure will be similar for all units.

AN EXPLANATION OF CONTINUING EDUCATION UNITS

For student operators in the OPERATOR-IN-TRAINING category who will be taking the certification examination for Class I, this course is an opportunity to increase your knowledge and competence in the treatment of water for human consumption. Successful completion of the manuals will also, it is hoped, make passing the certification exam much easier. The Continuing Education Units which you will get by taking this course will not decrease the minimum one year operating experience requirement for a Class I certificate.

For student operators who now hold a Class I certificate, the completion of all twelve manuals in the course will reduce the currently required three years of total operating experience for Class II certification by approximately four months. Thus, if you complete the course, you will need only two years and eight months of total operating experience before you take the Class II exam.

Here is a listing of the Continuing Education Unit (CEU) value of each of the manuals.

Manual	CEU Value
General Plant Operation	1.4
Taste, Odor, and Color	0.6
Chemistry/Bacteriology	2.5
Chlorination	2.5
Fluoridation	0.6
Filtration	1.2
Hydraulics	0.6
Distribution Systems	1.2
Pumps	0.6
Wells	1.0
Cross Connections	0.4
Springs	0.4
Total	13.0

For comparison with other types of training previously available, the CEU conversions below are given.

Public Water Supply Operator's Short Course (given by State Department of Health Personnel)	4 CEUs
One Semester Hour of College Credit	1.5 CEUs
One Year of College Credits (30 semester hours)	45 CEUs

COMPETENCY: Define cross-connections and explain how a cross-connection could affect people in your service area.

Objective: Define "cross-connection", "back-pressure backflow", and "back-siphonage".

Objective: Describe three different situations you've read about in which a cross-connection caused consumers to become ill. Tell how each situation should be corrected. Tell how each situation could have been avoided.

Objective: Describe any potentially hazardous cross-connections in your plant or distribution system.

RESOURCES:

(a) "Cross-Connection Vocabulary", Resource Sheet.

(b) Cross-Connection Control Manual, U.S. Environmental Protection Agency, Water Supply Division, 1973. Available from EPA Forms and Publications Center, Route 8, Box 116, Hwy. 70 West, Raleigh, North Carolina 27612

(c) "Cross Connections", Water Works Operators Manual, Third Edition, 1972, Alabama Department of Public Health, Bureau of Environmental Health, Montgomery, Alabama, Chapter XXVII. *-Pink Appendix-*

(d) West Virginia State Department of Health Memorandum dated September 21, 1978, concerning required backflow prevention devices. *-Gold Appendix-*

LEARNING ACTIVITIES:

(a) Read the resources listed above to find information about cross-connections.

(b) Attend a lecture/demonstration on cross-connection and backflow prevention presented by the West Virginia State Department of Health.

(c) Using your knowledge about cross-connections, inspect your own treatment plant and distribution system. Check for any potentially hazardous cross-connections.

EVALUATION ACTIVITY:

Complete Evaluation Form # 58. You must answer all items correctly. You may not use references. The Evaluation Form contains questions about:

(a) defining "cross-connection", "backflow", and "back-siphonage";

(b) identifying potentially hazardous cross-connection and backflow situations.

CROSS-CONNECTION VOCABULARY

1. Air Gap Separation-- A physical separation between the free-flowing discharge end of a water supply pipe and an open to atmosphere receiving vessel having a minimum unobstructed vertical distance between the supply pipe discharge point and the flood level rim of the receptacle of twice the diameter of the supply pipe or one inch (2.54 cm), whichever is greater. *An example is a kitchen sink. There is a space between the faucet and the sink rim.*

2. Backflow- the entry of liquids, gases, or other substances into the drinking water supply.

3. Backsiphonage- backflow caused when the pressure in the water system is less than atmospheric.

4. Barometric Loop- a loop of pipe rising at least 35 feet above the highest outlet served by the pipe.

5. Check Valve- a device designed to let water flow in one direction only. It will close if the water tries to flow in the other direction. *(Single check valves are not approved backflow prevention devices.)*

6. Cross-Connection- any connection where liquids, gases, or other substances may backflow into the drinking water supply.

7. Degree of Hazard- this shows how dangerous a cross-connection might be. The larger the degree of hazard, the more dangerous the cross-connection.

8. Double Check Valve Assembly- two single check valves with watertight valves at each end of the assembly. This includes pressure gauges and/or connections for testing the water-tightness of each check valve.

9. Flood Level Rim- the edge of the vessel (sink, tub, or tank) from which water overflows.

10. Health Hazard- any *condition, device,* or *practice* which may be dangerous to consumers.

11. Interchangeable Connection- a device (or arrangement) that allows the *alternate* use of two water sources. That means both sources can't be used at the same time.

12. Low Pressure Cut-Off Device- a switch (or device) designed to shut a pump off when the pressure on the *suction* side of the pump falls below a certain level.

13. Non-Removable Device- a device which can not be removed without special tools or a device which cannot be removed without damaging the plumbing connections or the device.

14. Potable Water- water which is safe to drink.

15. Public Water Supply- a water supply which serves the general public.

16. Public Water Supply System- includes all the things used for water collection, treatment, storage and distribution.

17. Reduced Pressure Backflow Prevention Device- an assembly containing a minimum of two independently acting check valves, an automatically operated pressure differential relief valve located between the two check valves, and watertight valves located at each end of the assembly, together with suitable pressure gauges and/or connections for testing the operation of the device.

18. Water Consumer- the people and buildings supplied by the public water system.

19. Water Purveyor- the person operating or in charge of a water system.

20. Water Service Line- a water line that takes water from the public water main to an individual.

21. Vacuum Breaker Device- a device that has a moveable disc or check valve *and* an atmospheric vent made so that a pressure less than atmospheric in the supply line will open the vent and *prevent backsiphonage*.

Operator _____

Evaluator _____

Date _____

Write a brief definition for the three following terms:

1. Backflow: *the entry of liquids, gases, or other substances into a public or potable water system.*

2. Cross-Connection: *any connection when liquids, gases, or other substances may backflow into the drinking water supply.*

3. Back-siphonage: *backflow caused when the pressure in the water system is less than atmospheric.*

* * * * * * * * *

4. About 30 people in the north end of your town become ill one day with nausea, vomiting, and abdominal cramps. What would you do?

There is an obvious possibility of a cross-connection. Check to see if all the 30 people had been drinking water. Notify the State Health Department's Drinking Water Program. Check to find cross-connection and make necessary repairs. Disinfect lines. Collect samples for bacteriological analysis.

5. The day after your local fire department puts out a large industrial fire, about 50 people become ill with infectious hepatitis. As the water plant operator, what would you do?

The use of a large volume of water by the fire department may have caused backsiphonage. Check to see if all 50 people had been drinking the water. Notify the State Health Department's Drinking Water Program. Check to find a cross-connection and make necessary repairs. Disinfect lines.

6. A store manager called you and said that the water in all of the drinking fountains in his store was yellowish. As the water plant operator, what would you do?

This may indicate a cross-connection between the chilled drinking water and chilled water used for other purposes. Turn off all store drinking fountains. Check the system for cross-connections. Notify the State and Local Health Departments. Make the necessary repairs and disinfect lines.

COMPETENCY: Describe the different methods of cross-connection control.

Objective: Identify the five basic devices used for protection against cross-connections. Explain how each device works.

Objective: Identify the types of places where backflow prevention devices are required by the West Virginia State Board of Health.

Objective: State your legal responsibility as a treatment plant operator regarding cross-connection and backflow prevention.

Objective: Describe the precautions taken at your treatment plant and distribution system to avoid problems from cross-connections, back-siphonage, and back pressure backflow.

RESOURCES:

(a) CROSS-CONNECTIONS AND BACKFLOW PREVENTION REGULATIONS, Effective April 1, 1976, West Virginia State Board of Health. *-Yellow Appendix-*

(b) Cross-Connection Control Manual, U.S. Environmental Protection Agency, Water Supply Division, 1973.

(c) "Cross-Connection Protection Devices", Resource Sheet I.

(d) "USE THE RIGHT DEVICE - Cross-Connection and Backflow Prevention", Resource Sheet II.

LEARNING ACTIVITIES:

(a) Read the resources listed above to find information related to the objectives.

(b) Attend a lecture/demonstration on cross-connection and backflow prevention presented by the West Virginia State Department of Health.

(c) Using the "USE THE RIGHT DEVICE" Resource Sheet, inspect your own treatment plant and distribution system to see how it is protected against cross-connection and backflow problems.

(d) If your treatment plant and customers are not well protected against cross-connections and

backflow, determine what steps should be taken to better protect the plant and customers.

EVALUATION ACTIVITY: Complete Evaluation Form # 59. You must answer every question correctly. Use the West Virginia Cross-Connections and Backflow Prevention Regulations Manual as a reference during the evaluation. The evaluation has questions about:

(a) identification of cross-connection control devices

(b) places where backflow prevention devices are required

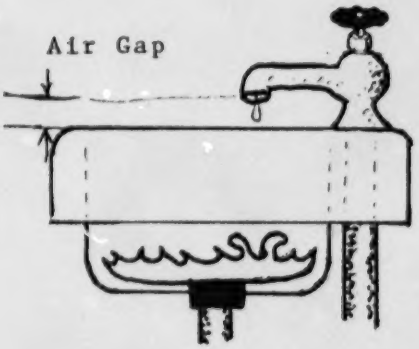
(c) W. Va. Department of Health regulations relating to cross-connections and backflow prevention

(d) cross-connections and backflow prevention at your treatment plant and distribution system

CROSS-CONNECTION PROTECTION DEVICES

AIR GAP

Air Gap is the physical separation of the potable and non-potable system by an air space. The vertical distance between the supply pipe and the flood level rim should be two times the diameter of the supply pipe. There should always be at least 1 inch distance. The Air Gap can be used on a direct or inlet connection and for all toxic substances.

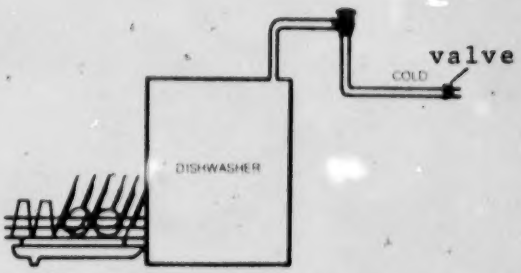


ATMOSPHERIC TYPE VACUUM BREAKER

Atmospheric Vacuum Breakers may be used only on connections to a non-potable system where the vacuum breaker is never subjected to back-pressure. It must be installed on the discharge side of the last control valve. It must be installed above the usage point. It cannot be used under continuous pressure.

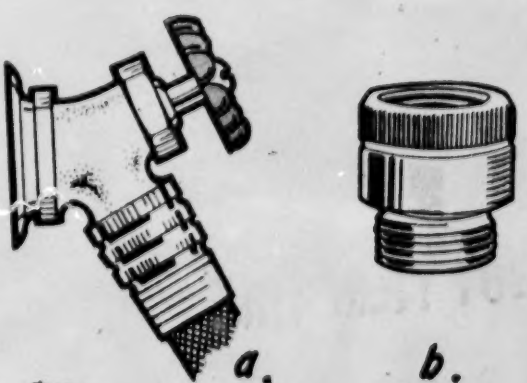
Applications:

Atmospheric Type Vacuum Breakers can be used on most inlet type water connections which are not subject to back-pressure, such as low inlet feeds to receptacles containing non-toxic substances, valve outlet or fixture with hose attachments, lawn-sprinkler systems, and commercial dishwashers.

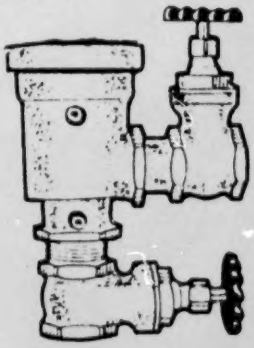


HOSE BIBB VACUUM BREAKER

Hose Bibb Vacuum Breakers are small, inexpensive devices with hose connections which are simply attached to sill cocks and threaded faucets - or wherever there is a possibility of a hose being attached which could be introduced to a contaminant. They should not be used under continuous pressure.

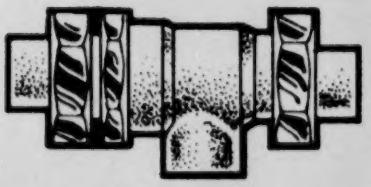


PRESSURE TYPE VACUUM BREAKER



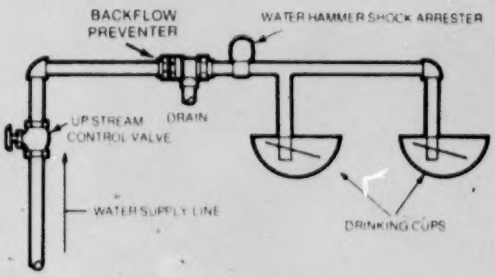
Pressure Type Vacuum Breakers may be used as protection for connections to all types of non-potable systems where the vacuum breakers are not subject to back-pressure. These units may be used under continuous supply pressure. They must be installed above the usage point.

BACKFLOW PREVENTER WITH INTERMEDIATE ATMOSPHERIC VENT



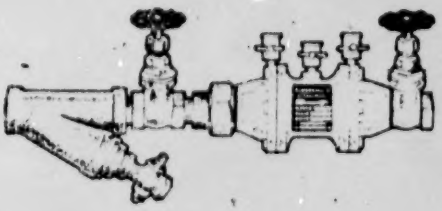
These devices are made for 1/2" and 3/4" lines and may be used as an alternate equal for pressure type vacuum breakers. They also provide protection against back-pressure.

Applications:



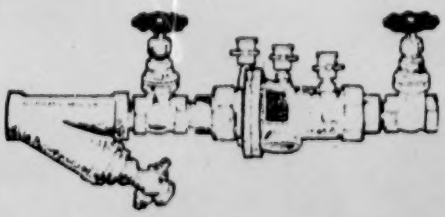
These devices are popularly used on boiler feed water supply lines, cattle drinking fountains, trailer park water supply connections and other similar low-flow applications. They will protect against both back-siphonage and back-pressure and can be used under continuous pressure.

DOUBLE CHECK VALVE ASSEMBLY



A Double Check Valve Assembly may be used as protection of all direct connections through which foreign material might enter the potable system in concentration which would be a nuisance---such as air, steam, food, or other materials which are not health hazards. *A double check valve assembly is not the same as two check valves in series.*

REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTER



Reduced Pressure Zone Devices may be used on all direct connections which may be subject to back-pressure or back-siphonage. They may also be used where there is a possibility of contamination by a material that could be a health hazard.

USE THE RIGHT DEVICE

Cross-Connection and Backflow Prevention*

DIRECT WATER CONNECTIONS SUBJECT TO BACK-PRESSURE FROM:

1. Pumps, tanks, lines handling
   a. Sewage Substances
      *Air Gap, Reduced Pressure Zone***

   b. Toxic Substances
      Air Gap, Reduced Pressure Zone

   c. Non-Toxic Substances
      Air Gap, Reduced Pressure Zone, double check valve with Intermediate Atmospheric Vent. See also State Department of Health Memorandum, Gold Appendix.

2. Steam lines and steam boilers
   a. Boiler or steam connection to toxic substances
      Reduced Pressure Zone, Air Gap

   b. Boiler or steam connection to non-toxic substances (boiler blow-off not connected directly to sewer)
      Double Check Valve, Reduced Pressure Zone, Air Gap, Backflow Preventer with Intermediate Atmospheric Vent

   c. Car wash installation
      Reduced Pressure Zone

INLET TYPE WATER CONNECTIONS *NOT* SUBJECT TO BACK-PRESSURE:

1. Waste line (not subject to back pressure due to waste line stoppages)
   Air Gap, Atmospheric Vacuum Breaker, Pressure Vacuum Breaker, Reduced Pressure Zone

2. Low inlet to receptacles containing toxic substances
   Reduced Pressure Zone, Air Gap, Atmospheric Vacuum Breaker, Pressure Vacuum Breaker

*Adapted from "Cross-Connection Information Handbook", H-CC-75l, Watts Regulator Company, Lawrence, Massachusetts.

**Devices recommended for each type of connection written in italics. Preferred devices are underlined.

3. Low inlet to receptacles containing non-toxic substances
Atmospheric Vacuum Breaker, Air Gap, Backflow Preventer with Intermediate Atmospheric Vent, Reduced Pressure Zone

4. Lawn sprinkler systems
Atmospheric Vacuum Breaker, Air Gap, Pressure Vacuum Breaker, Reduced Pressure Zone

5. Lawn sprinkler systems with fertilizer injection
Reduced Pressure Zone

6. Coils or jackets used as heat exchangers in compressors, degreasers or other equipment:
In toxic substances
Reduced Pressure Zone, Air Gap, Atmospheric Vacuum Breaker, Pressure Vacuum Breaker

7. Flush valve toilets
Atmospheric Vacuum Breaker

8. Toilet and urinal tanks
Air Gap, Atmospheric Vacuum Breaker

9. Valve outlets or fixtures with hose attachments which may constitute a cross-connection
   a. Toxic Substances
   Hose Connection Vacuum Breaker, Air Gap, Pressure Vacuum Breaker, Reduced Pressure Zone

   b. Non-Toxic Substances
   Hose Connection Vacuum Breaker, Air Gap, Pressure Vacuum Breaker, Reduced Pressure Zone

10. Plating Tanks
Reduced Pressure Zone, Air Gap

11. Vats and vessels used for degreasing, descaling, stripping, pickling, dipping
Reduced Pressure Zone, Air Gap

12. Water cooled equipment which is sewer connected
Reduced Pressure Zone, Air Gap

13. **Fire fighting systems which are treated for scale or algae formation or contain anti-freeze, Fomite, or other chemicals**
Reduced Pressure Zone, Air Gap

14. **Untreated fire fighting systems**
Double Check Valve, Air Gap, Reduced Pressure Zone

15. **Greenhouses**
Reduced Pressure Zone

EVALUATOR'S COPY

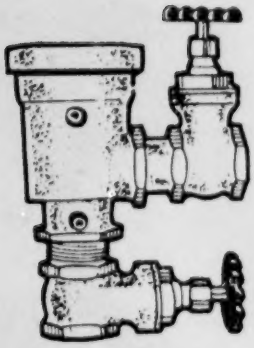
Operator _____

Evaluator _____

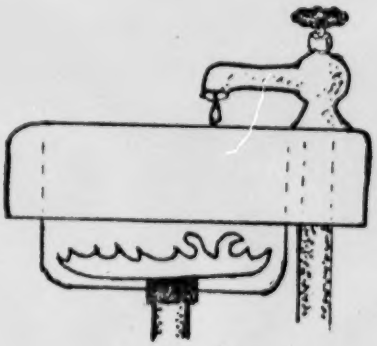
Date _____

1.-5. Write the correct name under each of the cross-connection devices shown below. Choose from the list given below.

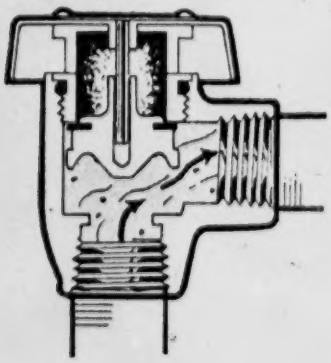
a. Air Gap
b. Atmospheric Vacuum Breaker
c. Pressure Type Vacuum Breaker
d. Double Check Valve Assembly
e. Reduced Pressure Principle Backflow Preventer



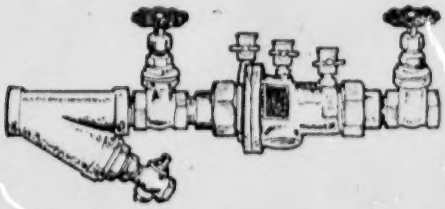
c. Pressure Type Vacuum Breaker



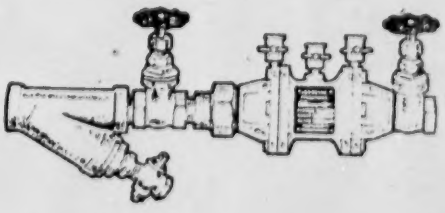
a. Air Gap



b. Atmospheric Vacuum Breaker



e. Reduced Pressure Principle Backflow Preventer



d. Double Check Valve Assembly

6.-20. Put a check (✓) next to the places that must have backflow prevention devices approved by the W. Va. Department of Health.

✓ Hospitals, mortuaries, clinics, nursing homes, animal hospitals

✓ Public swimming pools

___ Apartment houses

✓ Car washes, laundermats

✓ Laboratories

✓ Sewage treatment plants, sewage pumping stations

✓ Petroleum processing or storage plants

✓ Storm water pumping stations

✓ Chemical plants, dyeing plants

✓ Metal plating industries

✓ Tanneries

___ Mobile homes

✓ Slaughterhouses, poultry processing plants

✓ Food or beverage processing plants

✓ Piers, docks, waterfront facilities

✓ Photo development plants

✓ Farms where water is used for other than household purposes

For each item below write "TRUE" or "FALSE" and the W. Va. regulation number that relates to the question. If you answer "FALSE" write the correct answer on the lines under the question. *Refer to the West Virginia CROSS-CONNECTIONS AND BACKFLOW PREVENTION REGULATIONS.*

21. *TRUE* No person can have a cross-connection between a non-potable source and a water system used by the general public where polluted or contaminated water could reach the public.

Reg.# *3.5*

22. *TRUE* An approved air gap separation must be installed where the water supply could be contaminated with a substance that could cause a severe health hazard.

Reg.# 5.1.1

23. *TRUE* It is O.K. to install a removable vacuum breaker device or barometric loop where the degree of hazard is low.

Reg.# 5.1.4

24. *FALSE* It is O.K. to install barometric loops or vacuum breakers where backflow due to back pressure might occur.

Reg.# 5.1.5

These devices are not acceptable where backflow due to backpressure might occur.

25. *TRUE* Any booster pump must have a check valve on the discharge line.

Reg.# 5.3

26. *TRUE* The consumer must pay for the purchase, installation, and maintenance of a backflow device whether or not s/he wants the device.

Reg.# 6.3

27. *TRUE* Each water treatment plant must have a cross-connection and backflow prevention program.

Reg.# 7.2

28. *FALSE* Fire protection systems including sprinklers do not have to have backflow prevention devices.

Reg.# *4.4.2*

29. What changes, if any, should be made in your treatment plant or distribution system to protect against cross-connections and backflow?

CROSS-CONNECTIONS*

This appendix will give particular reference to the pollution of potable water systems due to uncontrolled cross-connections, and to present information needed to implement an effective Cross-Connection Control Program.

Why is this a timely subject? Because during the past 25 years, more than 100,000 persons have contracted a waterborne disease, resulting in more than 400 deaths. Four massive waterborne disease outbreaks have occurred during the past several years involving an estimated 40,000 persons. Such disasters are preventable and are, therefore inexcusable. The American public is entitled to drink water from the public systems with confidence and with the expectations that it has not been fouled with sewage from someone's toilet. This shameful condition is well known to health and water authorities throughout the nation and the need for taking remedial action was very forcefully brought to the attention of the Secretary of Health, Education, and Welfare in a report dated June, 1967, by The Task Force on Environmental Health and Related Problems. The report is entitled A Strategy For A Livable Environment and reads in part as follows:

"Water quality is at a shocking level for the wealthiest nation in the history of the world. About one third of the 19,200 communities in the United States which have municipal water systems fail to meet existing Public Health Service Standards." And further, "Fifty million Americans drink water that does not meet Public Health Service Drinking Water Standards. Another 45,000,000 Americans drink water that has not been tested by the Public Health Service."

There are many ways whereby a public water distribution system can become contaminated aside from contaminations of its source water. In most public water systems you can find a drainline cross-connected to a sanitary sewer or to a stormsewer; a bypass arrangement around an airgap or other protective device; or an emergency or standby cross-connection to another water system that is supplied with a contaminated water. Another less publicized and potentially more dangerous cross-connection problem is the customer's service connection. It is a well-known fact that there are literally millions of uncontrolled cross-connections on the customer's premises. Should some person become ill due to backflow of contaminants through a service connection, the water purveyor could be held to be negligent. He is committing an unlawful act when he installs or maintains a service connection to a customer's water system when he knows, or should know, that there are cross-connections on the premises. With this in mind, it can be readily seen that the failure to control in-plant cross-connections is not our only problem; we have the far greater responsibility of protecting the public potable water system from possible contamination.

*Source: Water Works Operators Manual, Alabama Dept. of Public Health, Bureau of Environmental Health, Third Edition, 1972, Chapter XXVII.

Just what is a cross-connection and why does its existence create a threat to public health? To provide an answer to that and other questions, we should explore some of the aspects of the cross-connection control problem. A cross-connection is any actual or potential connection, physical or otherwise, through which or because of which, a non-potable water or other fluid, could flow or pass into a potable water system or facility. A cross-connection is not in itself dangerous. It is only when a contaminated fluid passes through it and into a potable water system, that a health hazard is created. This phenomonon is called "backflow". The term, in this context means the flow of gas, water, or other liquid, mixture or substance into a public or private potable water system from any source other than that intended.

Backflow may occur at any time when there is an imbalance in the hydraulic forces in a potable water system whereby a non-potable water can be forced or drawn into the potable water system. Two terms are commonly used in describing this phenomonon; backpressure and backsiphonage. Backflow due to backpressure will occur when a superior pressure is generated in a non-potable water system or in the customer's in-plant water system by a pump, a pressure vessel such as a steam boiler or other pressure producing equipment. Or, the superior pressure may be due to a difference in elevation. Backflow due to backsiphonage is caused by atmospheric pressure which when exerted upon a body of water will force the water into a connected potable water piping system in which there is a vacuum or partial vacuum. In either case, a non-potable substance can be forced to "backflow" through a cross-connection into a potable water system when the hydraulic gradient is favorable.

"Backflow" of a fluid that is contaminated or polluted can result in the contamination or pollution of the inter-connected public or private potable water system. Such unintentional backflow is of public health significance when the fluid is in a form or concentration that would constitute a hazard to public health, create a nuisance, or be objectionable when introduced into a potable water supply. The degradation of a potable water supply can vary in intensity from a degree that will begin to cause an impairment of the quality of the water in a very minor way, to a degree which could, if the water were to be ingested cause sickness or instant death.

The degree of hazard is a very important public health factor and must be taken into consideration when developing an effective cross-connection control program. The protective device used, or measures taken to prevent backflow, must always provide protection commensurate with the degree of hazard.

In the field of cross-connection control typical hazards have been classified; the most important of which is the health hazard. It is described as any condition, device, or practice employed in the construction, operation or maintenance of a potable water system which could create a danger to the health and well-being of the water consumer. As an example; a health hazard will be created when sewage, chemicals, pesticides or other toxic materials back-

flow into a potable water system. Many disease outbreaks have been caused by backflow of sewage contaminated water through service connections to ships. Plumbing type cross-connections are also considered to be health hazards and they may be extremely dangerous when located in multi-storied buildings such as: hotels, apartment houses, hospitals, medical and dental buildings or in any building having a bacteriological or chemical laboratory. Typical of the plumbing type cross-connections to be found in such premises are: direct connections to sewers, or indirect connections to such facilities as flush valve toilets, bedpan washers, aspirators, darkroom facilities, instrument sterilizers, hydro-therapy tubs, colonic irrigators, etc.

The next hazard in order of its importance, and this hazard will affect the financial stability of a water purveyor, is a system hazard. A system hazard creates an actual or potential threat of severe damage to the physical properties of the public potable water system. For instance, a water supply system contaminated with crude oil, hot paraffin or other solid or liquid substances could limit the usability of the water system, or could adversely affect the quality of the potable water in the system for a prolonged period of time.

The final classification is defined as any pollutional hazard which could cause minor damage to the physical properties of a water sytem, or could pollute a water supply to a degree which would constitute a nuisance or be aesthetically objectionable. The pollutants, however, would not be dangerous to health. For example; the water having an objectionable taste or odor could contain syrup, beer, soda pop, etc.

When developing cross-connection control regulations, water and health authorities must recognize that the owner of a premise, or a water user will, of necessity, require a direct water connection under pressure to polluted or contaminated plumbing fixtures, tanks, circulating water systems, auxiliary water systems, or other water-operated or water-using facilities. They must also recognize that in certain facilities it is physically and economicallly infeasible to eliminate or control all such cross-connections on a permanent basis. With these two factors firmly in mind, it is incumbent upon all responsible authorities to assure that such connections are controlled or protected in a practical manner; a manner that will permit the controlled use of water on the premise yet at the same time will minimize the incentive to install or re-install unprotected cross-connections.

This brings us to the problem of how may cross-connections be controlled most effectively. It should be obvious by now that there is no simple solution. Each customer will have varying water use requirements and it is essential that their needs are fulfilled in a safe and practical manner. Therefore, the cross-connection problem on each premise must be analyzed individually.

Currently in vogue are two accepted methods of controlling cross-connections. The one with which we are most familiar is the installation of an airgap or a mechanical device at the point of cross-connection. It has been found by experience that this method is not always effective, as the airgap will be bypassed or the devices will be removed or become inoperative because of lack of proper maintenance.

The second method is the containment method. This method involves the containment of contaminants within a non-potable portion of the inplant water system, or within the water customer's water system(s) by installing a backflow prevention device at the service connection. From the public health standpoint the latter concept is the most effective. This method will protect the masses and reduce the water purveyor's public liability to nil as it is a well-established fact that if a public water distribution system is supplied with a potable water and there are no cross-connections to the public system, other than the customer's service connection, the water in the public system will remain potable unless backflow of contaminated water occurs through the customer's service connection.

In-plant water systems never remain stable or static even in home systems. Changes begin during construction and continue when the new owner takes possession and will continue throughout the life of the facility. New equipment will be installed, replete with cross-connections; piping changes will be made, bypassing or eliminating protective devices on existing cross-connections, or new cross-connections will be installed. Even if there are no physical in-plant changes made, a system will not remain static; vacuum breakers and other types of mechanical backflow preventers will deteriorate with age and improper maintenance practices, thus creating new hazards. Constant vigilance must be your watchword.

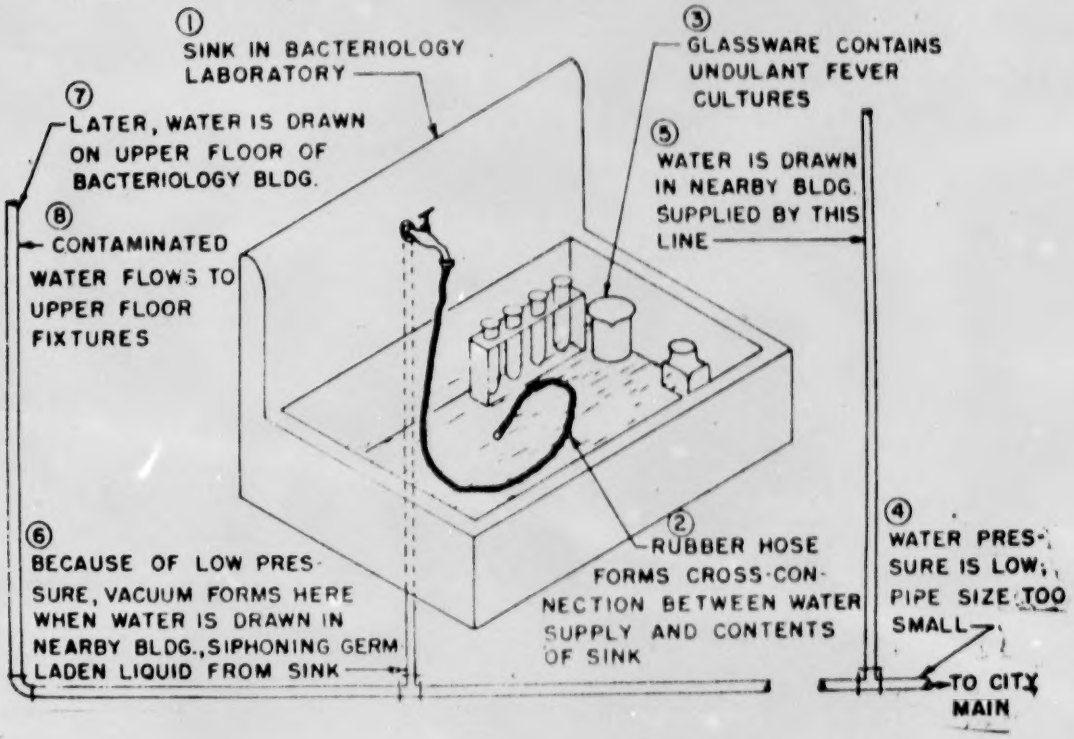
Many water purveyors have expressed the opinion that there is no need for them to take preventive measures to control cross-connections because backflow into their water systems would be either impossible or beyond the realm of expectation. Their reasoning is that they have always maintained a higher water pressure at the service connection than could be generated in the customer's system. Further, they say why worry? They chlorinate the water supply! This is false reasoning and can lead to disaster, because during times of emergency a normal pressure does not prevail, nor does the chlorine demand remain constant.

Pressures in either the public or the private system can vary from normal to either a complete vacuum, or a very high head. This means that, where there are cross-connections in existence, a potable water system can become dangerously contaminated through a sudden reversal in direction of flow. There is, therefore, no dependable normal pressure range in a public or private water system that can be used as a yardstick for predicting the pressure differential where backflow may occur.

Regarding chlorination of a public water supply, it should be thoroughly understood that the disinfection properties of chlorine are limited and that the residual of 0.2 to 0.4 ppm of free chlorine normally maintained in a properly chlorinated water system will not disinfect a water supply that has been contaminated with any appreciable amount of sewage, particularly where solid fecal matter is involved. It would require 100 to 200 ppm, plus a time factor, to properly decontaminate such a system, even after it has been thoroughly flushed. Furthermore, the available free chlorine residual would have no beneficial effect if the contaminant was a toxic chemical.

In the absence of a backflow prevention device, backflow into the public water system can and will occur due to pressure differentials during an emergency, even though the normal source pressure is greater than normal in-plant pressures. Further, the normal free chlorine residual maintained in a potable water system will not be effective in the disinfection of a water supply that has been contaminated. See Figure 1.

Figure 1
CROSS CONNECTION CAUSES FATALITY---This diagram shows a cross-connection in a laboratory that led to one death and 80 cases of undulant fever. An unfortunate set of circumstances resulted in this outbreak but how many cases of "doesn't this water taste funny to you?" could be traced to cross-connections?


① SINK IN BACTERIOLOGY LABORATORY
③ GLASSWARE CONTAINS UNDULANT FEVER CULTURES
⑦ LATER, WATER IS DRAWN ON UPPER FLOOR OF BACTERIOLOGY BLDG.
⑤ WATER IS DRAWN IN NEARBY BLDG. SUPPLIED BY THIS LINE
⑧ CONTAMINATED WATER FLOWS TO UPPER FLOOR FIXTURES
⑥ BECAUSE OF LOW PRESSURE, VACUUM FORMS HERE WHEN WATER IS DRAWN IN NEARBY BLDG., SIPHONING GERM LADEN LIQUID FROM SINK
② RUBBER HOSE FORMS CROSS-CONNECTION BETWEEN WATER SUPPLY AND CONTENTS OF SINK
④ WATER PRESSURE IS LOW; PIPE SIZE TOO SMALL
TO CITY MAIN

The Implementation of a Cross-Connection Control Program

I. Objective

Let us now take up the specific problem of initiating a new cross-connection control program---the first thing that must be done is to determine the objective we wish to obtain. That is, are we going to assure the potability of water for all users, or are we going to permit some consumers to drink a contaminated water? A complete program is advocated; one that will assure a safe water for all. Therefore, it is suggested that a program be implemented in the following manner:

(a) Protect the municipalities' public potable water supply from the possibility of contamination by isolating within its customer's private water system(s) contaminants or pollutants which could, under adverse conditions, backflow through uncontrolled cross-connections into the public water system; and

(b) Eliminate or control existing cross-connections, actual or potential, between the customer's in-plant potable water system(s) and non-potable water system(s), plumbing fixtures and industrial piping systems; and

(c) Provide for the maintenance of a continuing program of Cross-Connection Control which will systematically and effectively control all actual or potential cross-connections which may be installed in the future.

II. Responsibility

Next, we must fix the responsibility of the parties. In doing so, we must take into consideration the need for collaboration between the water purveyor, health authorities, and the customer, or water user. It is generally conceded that the water purveyor has the responsibility for preventing the backflow of water or any other unwanted substance from entering the public water supply system. The health agency has the overall responsibility of health within the city. Therefore, they have a responsibility with the plumbing inspector to search for, find, and abate unapproved connections to the potable water supply system within the water customer's premises. The customer has the legal responsibility to maintain his water system free of cross-connections and to comply with all State and City laws, rules and regulations pertaining to the control of cross-connections. The responsibilities of the parties should be clearly delineated and their duties and powers specifically spelled out in an ordinance, or in a regulation. The following would appear to be minimal in that regard:

(a) *Responsibility of the Chief (Health or Plumbing) Inspector.* The Chief Inspector or his designated agent with due diligence shall inspect the plumbing in each building or premise in this city to ensure that the plumbing located therein has been installed and is being maintained in such a manner as to prevent the possibility

of pollution of any potable water supply. The Chief Inspector shall notify, or cause to be notified in writing, the owner or authorized agent of any such building or premises to correct within a reasonable time, set by the Chief Inspector, any defective plumbing installed or existing contrary to, or in violation of this ordinance which, in the judgement of the Chief Inspector could cause the pollution of such water supply, or which could otherwise adversely affect public health.

The Chief Inspector, or his designated agent, shall have the right of entry into any building, during reasonable hours, for the purpose of making an inspection or reinspection of the plumbing systems installed in such building or premises; provided that, with respect to the inspection of any single family dwelling, consent to such inspection shall first be obtained from a person of suitable age and discretion therein or in control thereof. The Chief Inspector shall have the continuing responsibility for reinspecting the aforementioned plumbing in each building as frequently as in his judgement may be necessary to ensure that such plumbing is being maintained free of uncontrolled cross-connections and other defects that could adversely affect public health.

(b) *Responsibility of the Water Purveyor.* The water purveyor under existing State Laws has the primary responsibility for providing the public with a safe and potable water supply and for preventing water from an unapproved source, or any other deleterious substance, from entering the public potable water supply system. In furtherance of this mandate, the water purveyor is hereby prohibited from installing and/or maintaining a water service connection to a customer's premise where an uncontrolled cross-connection, either actual or potential, is maintained contrary to the provisions of this code, unless the public potable water supply is protected against backflow through such uncontrolled cross-connection, by installing an approved backflow prevention device at the service connection.

The water purveyor's responsibility shall begin at the source and include all of the public water distribution system, the service connection, and shall end at the point of delivery to the consumer's premise. The water purveyor shall exercise reasonable care and vigilance to ensure that the consumer has taken the necessary steps to safeguard the public water system from contamination, and shall conduct or cause to be conducted, periodic inspections of his customer's water system in order to determine whether there are any uncontrolled cross-connections, actual or potential, on the premise. When the water purveyor finds that there are uncontrolled cross-connections on the premise, or that the customer is operating his system in a manner that could adversely affect the public system, he shall require the customer, at his own expense to:

(1) Install an approved backflow prevention device at each service connection to his premise(s); and

(2) Test such device annually or more often when deemed necessary; and

(3) Properly repair and maintain such device or devices and keep adequate records of each test and subsequent maintenance and repair, including materials or replacement parts.

The water purveyor's judgement as to the need for installing a backflow prevention device at the service connection shall be final and his responsibility for making continuing in-plant inspections of his customer's water system(s) shall cease when the customer has installed at the service connection, an approved backflow prevention device which will afford maximum protection for the public water system. The water purveyor shall have the continuing responsibility to ensure that the backflow prevention device is properly maintained.

The water purveyor or his designated agent shall have the right of ingress to and egress from, his customer's premises at all reasonable hours on any purpose reasonably related to the furnishing of water service and the exercise of any and all rights secured to it by law or this code, including inspection of the customer's piping and equipment as to compliance with this ordinance or any other pertinent law or regulation.

(c) *Responsibility of the Consumer.* The consumer has the primary responsibility of preventing pollutants and contaminants from entering his potable water system(s) or the public potable water system.

The consumer's responsibility starts at the point of delivery from the public potable water system and includes all of his water systems.

The consumer, at his own expense, shall install, operate, test and maintain approved backflow prevention devices as directed by the authority having jurisdiction. The consumer shall maintain accurate records of tests and repairs made to backflow prevention devices and provide the water purveyor or health agency having jurisdiction with copies of such records. The records shall be on forms approved by the water purveyor and/or health agency having jurisdiction and should include the list of materials or replacement parts used. Following any repair or overhaul of a device, the consumer should have it retested to insure that it is in good operating condition and will prevent backflow. Tests, maintenance and repairs of backflow prevention devices should be made by a person and in a manner approved by the agency having jurisdiction.

When requested by the water purveyor or by the Chief Inspector, the consumer shall appoint a water supervisor who shall be responsible for conformance with all applicable laws, rules and regulations pertaining to cross-connection control; for the installation, operation and use of all water piping systems, backflow prevention devices and water-using equipment on the premises; and for the avoidance of uncontrolled cross-connections. The water supervisor should be the consumer, or any full-time employee appointed by the consumer who has a thorough knowledge of the installation, operation and maintenance of all water systems and backflow prevention devices

on the consumer's premise(s). In the event of accidental pollution or contamination of the public or the consumer's potable water system due to backflow on or from the consumer's premise(s), the owner or water supervisor should promptly take steps to confine further spread of the pollution or contamination within the in-plant system and should notify the local health officer and the water purveyor of the hazardous condition. The person responsible for the consumer's water system(s) (consumer or water supervisor) should take appropriate measures to free his water system(s) of any pollutants or contaminants.

The consumer shall provide and maintain reasonable access for Water Department representatives to all service connections, meters, backflow prevention devices, or other facilities pertinent to water service installed on his premises.

III. Policy

Thus far, we have delved into the need for establishing a viable cross-connection control program. We have analyzed some of the basic fundamentals, taken a look at the in-plant cross-connection problem, established our objectives and have fixed the responsibilities and duties of the parties. We are now ready to define the municipalities' policy relative to the protection of the in-plant water system and the public water system.

Previously, it has been pointed out that cross-connection control is a two-phase problem. Both the public water system and the in-plant system are important to the health and welfare of all water users in the city. It has been also pointed out that is is physically and economically infeasible to find and eliminate permanently, all cross-connections on the customer's premises. Therefore, there must be a coordinated effort to the end that the in-plant health hazard is minimized and the users' of water from the public water system will be completely protected.

(a) *Cross-Connection Control---In-Plant Policy.* An airgap or an approved backflow prevention device should be installed at the point of cross-connection to each plumbing fixture where there is a danger of backflow and/or backsiphonage. (See Table I for guidance in determining the degree of hazard and the types of backflow preventers available.) Where it is impractical, or physically and economically infeasible to find and/or permanently eliminate or control all actual or potential in-plant cross-connections; control by "containment" should be utilized. That is: the potable line or a portion of the in-plant system supplying water to such cross-connections should be designated as a non-potable "industrial piping system". Backflow or backsiphonage from the non-potable system into the potable water system should be prevented by installing an approved reduced pressure device on the supply line to the non-potable "industrial piping system", or to that portion of the in-plant water system where such actual or potential cross-connections are located. All exposed or accessible portions of in-plant non-potable water lines should be identified in a satisfactory manner.

DEFINITIONS OF CROSS-CONNECTIONS, HAZARDS, AND RECOMMENDED TYPES OF BACKFLOW PREVENTION DEVICES AGAINST THESE HAZARDS

TABLE I

	Degree of Hazard			Recommended type of Backflow Preventer			
	Severe	Moderate	Minor	Air Gap	Reduced Pressure Device	Pressure Vacuum Breaker	Atmos. Vacuum Breaker
I. Direct Water Connections subject to pressure							
A. Pumps, tanks, and lines handling:							
1. Sewage and lethal substances	x			x	x		
2. Toxic substances *	x			x	x		
3. Non-toxic substances **		x		x	x		
II. Direct or Indirect Water Connections not subject to pressure							
A. Sewer connected waste line (not subject to waste stoppages.)	x			x	x	x	x
B. L.I. to receptacles containing toxic substances *	x			x	x	x	x
C. L.I. to receptacles containing non-toxic substances **		x		x	x	x	x
D. L.I. into domestic water tanks			x	Each case should be treated separately			
E. Lawn sprinkler systems	x			x	x	x	x
F. Coils or jackets used as heat exchangers in compressors, degreasers or other equipment:							
1. In sewer lines	x			x	x		
2. In toxic substances *	x			x	x	x	x
3. In non-toxic substances **			x	No protection is required			
G. Flush valve toilets	x						x
H. Toilet and urinal tanks		x		x			x
I. Trough urinals		x					x
J. Valved outlets or fixtures with hose attachments which may constitute a cross-connection:							
1. Toxic substances *	x			x	x	x	x
2. Non-toxic substances **		x		x	x	x	x
K. Water connection to steam and steam boiler:							
1. Boiler or steam connection to toxic substances *	x			x	x		
2. Boiler or steam connection to non-toxic substances ** (boiler blow-off through approved gap)		x		x	x		

* and ** Footnotes on following page.

Footnotes:

* TOXIC SUBSTANCE: Any substance (liquid, solid, or gaseous) including raw sewage and lethal substances which, when introduced into the water supply system creates or may create a danger to the health and well being of the consumer.

** NON-TOXIC SUBSTANCE: Any substance of a non-poisonous nature that may create a moderate or minor hazard to the domestic water system.
Examples:
1. Connections to food processing lines such as syrups, lard, beer, etc.
2. Connections to steam and steam boilers where the steam does not come in contact with poisonous materials.
3. McDaniel tees or steam clean-up connection in food plants, apartment house boilers, or pressing boilers.
4. Connections to enclosed circulating systems, such as radiant heating systems and refrigerated water systems.

Each outlet on the non-potable water line which may be inadvertently used for drinking or domestic purposes should be posted: DANGER--UNSAFE WATER. The examples which follow exemplify the cross-connection control by containment method:

1. Auxiliary Supplies---In-plant water systems that are used for fire-fighting and other purposes, which are supplied with water from an auxiliary source that cannot be approved as safe or potable for human use, or which contain anti-freeze solutions or other toxic additives, should be isolated from the in-plant drinking water pipelines by installing an approved reduced pressure principle backflow prevention device on each interconnection between the two systems. In addition, an approved backflow prevention device operating under the reduced pressure system should be installed on each public water service connection to the premise.

2. Industrial Fluids or Process Waters---Potable water pipelines connected to industrial piping systems or to equipment containing industrial fluids, sewage, used or process water or any other potentially contaminated liquid should be protected by installing a reduced pressure principle backflow preventer in the inter-connecting line. The device should be located beyond the last point from which drinking water may be taken. In addition, the public system should be protected at the service connection by installing an approved backflow prevention device at each service connection to the premise.

3. Sewage Treatment Plants and Sewage and Storm Water Pumping Stations---A backflow prevention device operating under the reduced pressure principle should be installed at each service connection from a public potable water system to any premise on which there is a sewage treatment plant, sewage, or storm water pumping station. This requirement pertains to all premises publicly or privately owned; including those having sewage pumps and

ejectors located in commercial buildings and private residences. The in-plant potable water system should be protected by installing a reduced pressure principle backflow prevention device on each cross-connection within the plant, or on the supply line to a non-potable "industrial piping system" used to supply priming or cooling water for pumps or water needed for purging measuring equipment, or for permanent, emergency, or standby connections to reclaimed water systems used for irrigation or industrial purposes.

4. Connections to Boilers---Potable water connections to boiler feed water systems in which boiler water conditioning chemicals are introduced should be made through an airgap or provided with an approved reduced pressure principle backflow preventer located in the potable waterline before the point where such chemicals are introduced. Boiler water conditioning chemicals are in most cases toxic; therefore, a double check valve will not provide adequate protection.

5. Refrigerating Unit Condensers and Cooling Jackets---Where a refrigerator is charged with a toxic refrigerant, an approved reduced pressure principle backflow preventer should be installed on the supply line to the refrigerator condenser or cooling jacket, except where the potable water is entirely outside of the piping or tank containing such toxic refrigerant. Also, adjacent to, and at the outlet side of the backflow preventer, an approved pressure relief valve set to relieve at 5 psi above the maximum water pressure at the point of installation, should be provided if the refrigeration units contain more than 20 pounds of refrigerants.

b. *Cross-Connection Control---Public Water Supply Policy.* The water purveyor's responsibility for preventing contamination of the public water system, due to backflow through the service connection, usually ends at the meter or service connection. There are however, exceptions to this rule. For instance, in the States of Washington and Massachusetts, the water purveyor must also maintain surveillance over his customers' system to the free flowing outlet of the ultimate consumer. In either case, the water purveyor must, if he wishes his program to be successful, adopt a policy of "Cross-Connection Control by Containment". That is, he must take cognizance of the fact that in-plant cross-connection control programs have been found to be notoriously ineffective in protecting the public water system from contamination. The water purveyor should, therefore, be prohibited from installing or maintaining a service connection to a customer's premises(s) where there are actual or potential cross-connections, unless there is reasonable assurance that backflow into the public water system cannot occur.

Summary and Conclusions

A water purveyor has a legal obligation to supply a safe water to his customer. He has a legal as well as a moral obligation to provide a safe water to the consumer and to prevent such water-borne disease outbreaks. The water purveyor cannot relegate his responsibility for maintaining a safe water supply to any other person or

agency; therefore, the failure of health or plumbing officials to effectively cope with the in-plant cross-connection control problem will not relieve him of his liability.

It is a well-known fact that in-plant cross-connections cannot be permanently eliminated; it is therefore believed that a water purveyor's legal obligation to supply a safe water to his customer can be fulfilled if it can be shown that he has in fact supplied his system with a potable water supply and has adopted and prosecuted a viable, comprehensive and effective plan of cross-connection control by containment. In those states where the water purveyor has the responsibility for protecting the customer's in-plant water system to the point of use, he can apply the "containment" policy in a like manner, to protect the customer's water system.

With our very lives at stake, it would appear that now is the time for every responsible water official to make a re-assessment of his obligation to the public, because the failure on his part to effectively control dangerous cross-connections can be disastrous to him professionally and to the community he serves. The water purveyor knows that in dealing with the cross-connection problem he is dealing with a myriad of time bombs that have been activated and deposited throughout his city! He knows it will be only a matter of time before a bomb will explode--just as surely he should know that in time, backflow will occur and that when a water-borne disease outbreak does occur, the water purveyor will have to prove that the outbreak was not due to negligence on his part.

The customer who installs a cross-connection and who benefits by its use should be required to pay for the installation, testing, and maintenance of the backflow prevention device needed to control it. A water purveyor should never gamble "Lives against Dollar", by maintaining cross-connections--a health hazard--it could be expensive.

This appendix was condensed from material furnished by Roy O. VanMeter, who for more than 30 years was in charge of cross-connection control for the Department of Water and Power, City of Los Angeles.

PUBLIC HEALTH SIGNIFICANCE OF CROSS-CONNECTIONS*

According to the official investigation of the 1933 Chicago epidemic of amebic dysentery, *"...old and generally defective plumbing and cross-connections potentially permitting backsiphonage from fixtures such as bathtubs and toilets..."* were to blame for contamination of the drinking water supply.

The event and its sad result - the death of 98 persons - dramatized the concern that public health officials feel about the dangers of cross-connections. Because such plumbing defects are so frequent, and the opportunity for contaminants to invade drinking water through cross-connections is so general, enteric infections caused by drinking water may occur in almost any city on any day.

Published histories of massive enteric infections caused by cross-connections abound. While the following cases have their natural appeal as historical literature, they are listed here mainly to illustrate the serious consequences of cross-connections, their ubiquity, their frequency, and their peculiarity.

Brucellosis at the Faucet

In 1938, 80 students at a large midwestern university reported remittent fevers, malaise, headache, and anemia. Their symptons led to a diagnosis of undulant fever (brucellosis). Curiously, only those students who had been working in the cultivation of bacteria in one of the laboratories were affected. The mystery was how the brucella cultures in the laboratory could have been transmitted to the students. Finally, a hose was found connected to a faucet in the laboratory. The other end of the hose was submerged in water containing brucella. A temporary reversal of pressure, possibly the consequence of a demand for water in another part of the system, had drawn the water teeming with brucella into the drinking supply. Of the 80 students affected, one died.

Sewage in the Water Main

In Newton, Kans., in 1942, one of the town's two water supply mains had been taken out of service on September 2, 7, and 8. A house service connection to this main supplied three frostproof hydrants and two frostproof toilets. It was assumed, from subsequent events, that some unknown person or persons tried to obtain water from a hydrant connected to the main out of service. When no water flowed, the anonymous agents departed, leaving the valve open.

*Source: The U.S. Environmental Protection Agency Cross Connection Control Manual.

On September 10, it was discovered that a neighboring toilet sewer was clogged and that sewage had overflowed into the hydrant box. It was learned that for 2 days all the sewage from the toilets of 10 families had been permitted to flow into the water main. When the main was put back into service, there was no attempt to sterilize it. More than 2,500 persons in all parts of the town suffered enteric disorders as a result. Stool cultures and pathological findings from two autopsies diagnosed the illness as bacillary dysentery. In addition to the widespread illness in the town, it is believed that the infection was carried aboard a number of troop trains which were watered in Newton at that time.

Pressure Drop

In 1942 a casting plant in Pittsburgh employing 500 persons undertook to install new water connections. During installation, the city water supply was shut off. It is believed that a drop in pressure in the drinking water lines of the plant permitted river water to pass through a valved connection to the drinking water. Twelve hours after the first new connection to the city water was installed many of the employees suffered mild intestinal disorders. Two weeks later, after another shutdown to make a second connection from the plant system to the city water, there was a second outbreak of intestinal disturbances among the employees.

Defective Valve

Aboard a vessel in a west coast shipyard in 1943, a valve on the main line, connecting the drinking water to the fire water supply, was found to be defective and the cause of an outbreak of gastroenteritis. The pumping of contaminated harbor water through the fire waterlines aboard the vessel had forced bacteria into the drinking supply through a cross-connection. As a result, 1,179 men became ill.

Arsenic in Reverse

A California laborer had been using an aspirator, attached to a garden hose, to spray a driveway with weedkiller containing arsenic. Sometime while he was at the job, the water pressure reversed. Taking no notice of the incident, the man disconnected the hose and, feeling thirsty, drank from the bib of the hose connection at the house. Arsenic in the waterline killed him.

Peak Demands

At a large aviation plant on the west coast, officials learned that the difference between a 3-inch water main and an 8-inch main was the determining cause for a high rate of absenteeism. When it was

discovered that 25 to 40 percent of the employees were suffering from gastroenteritis, the plumbing system was suspected. Investigators found that there was such a demand on the 3-inch main at peak periods that the outflow produced enough of a vacuum to allow waste water to be backsiphoned through cross-connections into the drinking water system. After an 8-inch main was installed, the high rate of infection subsided.

The Vacuum Breaker

In April 1944, after an outbreak of gastroenteritis in an Oklahoma school, it was found that none of the flushometer valve toilets with submerged inlets were provided with vacuum breakers, which prevent atmospheric pressure from forcing waste water into the supply lines. Each night to conserve water and eliminate the possibility that rooms might be flooded if a leak should develop, the custodian turned off the valve of the main supply line. As the pressure in the supply lines was cut off, atmospheric pressure on the toilet bowls moved the waste water up into the drinking supply. Most of the people affected were those who drank from faucets on the first floor of the school; there were progressively fewer cases on the second and third floors, as the atmospheric pressure moved less of the waste water to those heights.

Wrong Valve

At a school in Milford, Nebr., the fire lines and hydrants were separate from the domestic water supply, although the two systems were connected through a valve at the pumphouse. The souce of water for the fire system was the river. In January, 1947, following a fire, someone negligently opened the connecting valve at the pumphouse, and river water entered the domestic water supply. About 150 people came down with gastroenteritis.

Ten-Percent Polio Incidence

In 1932 during a 5-week period, more than 10 percent of the 347 children in Huskerville, near Lincoln, Nebr., contracted polio. A study of the water supply revealed that the afflicted children lived in areas where flush valve water closets lacked vacuum breakers. A time relationship was found also in places where extreme fluctuations of pressure in the water mains might have permitted waste water to be forced into the drinking supply.

Dysentery at Sea

In 1952 a large oceangoing vessel set sail from its berth with every indication that things were shipshape. A day or so later and 300 miles out, over a thousand cases of dysentery developed among those

on board. Contaminated water was blamed for the episode and the evidence indicated that while tied up at its moorings, the ship's fresh-water tanks had been contaminated. A cross-connection was the most likely explanation.

A Drink of Chromates

Chromates are one of the chemicals for which the Public Health Service Drinking Water Standards prescribe the very low amount of 0.05 parts per million as the limit that can be tolerated in a drinking water supply. In 1958 an employee using a drinking water fountain in a large city library noticed that the water stream issuing from the spout was yellowish, and the matter was called to the attention of the building engineer. Upon investigation, it was found that the chilled-water pipe system supplying the fountains was directly connected to another chilled-water system in which heavy dosages of chromates were used for corrosion control. Someone forgot to close the valve!

Harbor Water Threatens Vessel Crews

At about 2 p.m. on June 29, 1960, on a large pier installation in an eastern port harbor, a worker noticed evidence of salt in the potable water supply. Investigation showed that salt water from the harbor had been pumped into the pier's potable water pipes. The fire systems of three vessels anchored nearby had been connected to the fresh water piping system and high fire-pump pressures apparently did the rest. One measurement of chlorides at a "fresh" water outlet showed 6,425 parts per million. Only prompt and vigorous action by a sanitary engineer is believed to have prevented widespread illness.

Antifreeze

Usually service stations supply antifreeze for automotive equipment, not for people to drink. The reverse was true during October of 1961 when there occurred one of the most bizarre backsiphonage episodes on record. In a midwestern city, ethylene glycol antifreeze was being pumped from a large storage tank to an antifreeze distribution system. This system was cross-connected to the city water supply lines and it was estimated that over 100 gallons of 60 percent ethylene glycol were pumped into the water mains. Samples from the water pipes showed the presence of from 1.5 to 2.0 percent ethylene glycol, or up to 20,000 parts per million of this toxic chemical agent. A homeowner reported a bitter taste and reddish color to the water department. Radio announcements, a shutdown of the water supply to the area affected, and repeated flushings were required to cope with the situation.

Outbreak Fells Shipyard Workers

The time was 7 a.m. on September 28, 1962, at a large eastern shipyard. Beginning then and throughout the day, some 700 men reported ill with gastroenteritis. All had drunk water from the yard area where they worked and one water sample showed coliforms in excess of 240 per 100 milliliters. Investigators concluded that a tempoary cross-connection had been made between the potable water lines and pipes containing river water for firefighting purposes. They stated that "... *such an episode may occur again if steps are not taken to insure that such ill-considered cross-connections cannot be made by accident.*"

The foregoing incidents illustrate why public health officials earnestly caution builders, plumbers, maintenance men, and city planners on the correct design and installation of plumbing facilities. Even more important than the new installations are the many established systems that deserve review and correction.

The following incidents occurred after the publication of the first edition of this manual. They show that cross-connection continues to be a serious hazard to water supplies and only constant vigilance in their detection and elimination can reduce the ever-present risk of contamination from these sources.

Arsenic Poisoning

On a private farm in Texas in 1963, five people were poisoned with arsenic from drinking water. The source of drinking water was a cistern. A cotton defoliant tank which contained arsenic was improperly connected to the cistern. Backsiphonage occurred, and of the five people who drank the water, three died.

Nurses Ill

Backsiphonage caused by defective plumbing in a new student nurses building was blamed for an outbreak of disease in 1963 in Ohio. It was necessary for 100 of the student nurses to be quarantined for 2 weeks. Bacteriological examination showed that the drinking water was contaminated. The city health commissioner theorized that salmonella was brought into the building by some of the girls and then spread by defective plumbing.

Eleven Vomiting Caddies

Eleven caddies experienced nausea, severe vomiting, and abdominal cramps after consuming a "soft drink" at a New York golf club in 1964. The beverage was commercially prepared by the mixture of sirup with carbonated water in a vending machine. Investigation revealed that a pipe carrying water into the machine was connected to the recirculating hot water heating system instead of the drinking water system. The day before the incident a lye and chromate solution was added to the hot water system.

Shigellosis

In 1967, an outbreak of gastroenteritis occurred at a small private college in Pennsylvania. Almost one-quarter of the 700 students and faculty were affected. The only factor in common to all those who became ill was the consumption of water or food that had been prepared using water from the school water system. Investigation of the water system revealed that a waterline had broken in the kitchen of the school cafeteria, flooding both the kitchen and the cafeteria. Cross-connections were found between the sewage system and the fresh water system that could have resulted in backsiphonage of sewage into the water system as a consequence of negative pressure during the break in the waterline. It was concluded that the outbreak probably resulted from the presence of Shigella sonnei in the water system. The inoculum would have been of sufficient size to overcome the chlorine in the water.

Football Team Stricken

In October 1969, most of the members and coaches of a college varsity football team became ill with infectious hepatitis. The water supply on the practice field was found to be the cause. A drinking fountain and the irrigation system for the field were on the same line. A heavy fire demand in the area had created a negative pressure in the waterlines and caused contaminated surface water around the sprinklers to be siphoned into the potable water lines. Players and coaches drinking from the fountain became ill and the school was forced to cancel the remainder of the football schedule.

Temporary Hydrant Connections

A serious emergency involving the contamination of a water supply was caused by a truck filling from a city water supply. In 1971, a contractor using a tank truck with a rig designed to pump and spray a mixture of water, fertilizer, grass seed, and woodpulp was working on the grounds of a subdivision. The contractor was using a direct connection to a fire hydrant to fill the tank with water, which was then mixed with the fertilizer, etc. A high-pressure pump then sprayed the mixture onto the ground. As the woodpulp circulated through the tank piping system, it plugged one of the lines while the pump continued to run, creating a very high pressure in the tank. This pressure was higher than the water supply system pressure and it forced the solution of fertilizer into the water system. Several people in the subdivision became ill after drinking the water, but the contamination was discovered and quick action in flushing and disinfecting the lines eliminated the danger.

WEST VIRGINIA STATE BOARD OF HEALTH

CHAPTER 1, ARTICLE 5B

CROSS-CONNECTIONS AND BACKFLOW PREVENTION REGULATIONS

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WEST VIRGINIA STATE BOARD OF HEALTH

CHAPTER 1, ARTICLE 5B

CROSS-CONNECTIONS AND BACKFLOW PREVENTION REGULATIONS

SECTION 1.0 GENERAL

1.1 Scope

1.1.1 This article replaces Section 11.0 of Article 5, Chapter 1, "Public Water Supply Regulations". Section 11.0 of Article 5, Chapter 1 is hereby repealed.

1.1.2 These regulations establish the rules and requirements of the West Virginia State Board of Health governing cross-connections and backflow prevention.

1.2 Authority - The authority for these regulations is provided under Chapter 16, Article 1, Public Health Laws, Code of West Virginia.

1.3 Filing Date - On Feb.13,1976, as prescribed by State Law, these regulations were filed with the Office of the Secretary of State, State of West Virginia.

1.4 Certification - These regulations were certified as being received and on file in the Office of the Secretary of State, State of West Virginia on February 13, 1976.

1.5 Effective Date - These regulations shall be in full force and effect on April 1, 1976.

SECTION 2.0 DEFINITIONS

The following definitions shall apply in the interpretation and enforcement of these regulations.

2.1 AIR GAP SEPARATION - A physical separation between the free-flowing discharge end of a water supply pipe and an open to atmosphere receiving vessel having a minimum unobstructed vertical distance between the supply pipe discharge point and the flood level rim of the receptacle of twice the diameter of the supply pipe or one inch (2.54 cm), whichever is greater.

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2.2 APPROVED - As used in these regulations shall mean accepted by the Division of Sanitary Engineering as being suitable for the proposed use.

2.3 APPROVED BACKFLOW PREVENTION DEVICE - An air gap separation, barometric loop, double check valve assembly, reduced pressure backflow prevention device, vacuum breaker device, or other device or means approved by the Division of Sanitary Engineering for preventing backflow.

2.4 AUXILIARY WATER SUPPLY - Any water source or system available within the building or premises other than the public water supply, including, but not limited to individual wells, springs and cisterns. A private water storage tank supplied by a public water supply system is considered an auxiliary water supply unless its design meets the minimum design standards required for storage tanks for public water supplies and the water contained therein is potable.

2.5 BACKFLOW - The entry or flow into a public or potable water supply system of liquids, gases or substances from any other source.

2.6 BACKSIPHONAGE - Backflow caused by less than atmospheric pressure in a water system.

2.7 BAROMETRIC LOOP - A loop of pipe rising at least thirty-five (35) feet (10.67 m) above the highest outlet served by the pipe.

2.8 CHECK VALVE - A mechanical self-closing device designed to permit the flow of fluids in one direction only and to close upon reversal of flow.

2.9 CROSS-CONNECTION - Any physical connection or other arrangement whereby backflow of liquids, gases or other substances into any public or potable water supply may occur.

2.10 DEGREE OF HAZARD - As used in these regulations shall mean the potential risk to health and potential adverse effects upon the public water supply based on the probability of backflow occurring and the type or nature of the contaminant.

2.11 DIVISION OF SANITARY ENGINEERING - As used in these regulations shall mean the Division of Sanitary Engineering, West Virginia State Department of Health.

2.12 DOUBLE CHECK VALVE ASSEMBLY - An assembly consisting of two single independently acting check valves with watertight valves located at each end of the assembly, and suitable pressure gauges and/or connections for testing the watertightness of each check valve.

2.13 FLOOD LEVEL RIM - The edge of the vessel or receptacle from which water overflows.

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2.14 HEALTH HAZARD - Any condition, device or practice which in the judgment of the Health Officer or the Division of Sanitary Engineering creates or may create a danger to the

health and well being of the water consumer.

2.15 HEALTH OFFICER - The State Director of Health or his authorized representative.

2.16 INTERCHANGEABLE CONNECTION - An arrangement or device which allows the alternate but not simultaneous use of two sources of water.

2.17 LOW PRESSURE CUT-OFF DEVICE - A switch or device designed to shut off a pump when the pressure at the suction side of the pump falls below a specified level.

2.18 NON REMOVABLE DEVICE - A device requiring special tools for removal or where removal will result in damage to the device or the connection thereto.

2.19 PERSON - Individual, partnership, association, syndicate, company, firm, trust, corporation, government corporation, institution, department, division, bureau, agency, or any entity recognized by law.

2.20 POTABLE WATER - Water free from impurities in amounts sufficient to cause disease or harmful physiological effects, with bacteriological, chemical, physical and radiological quality conforming to applicable regulations and standards of the State Department of Health.

2.21 PUBLIC WATER SUPPLY - Any water supply or system subject to regulation and control of the Public Service Commission of this state, or which supplies or offers to supply water to the general public.

2.22 PUBLIC WATER SUPPLY SYSTEM - Includes the works and auxiliaries for the collection, treatment, storage and distribution of the water from the source of supply to the ultimate consumer's premises.

2.23 REDUCED PRESSURE BACKFLOW PREVENTION DEVICE - An assembly containing a minimum of two independently acting check valves, an automatically operated pressure differential relief valve located between the two check valves, and watertight valves located at each end of the assembly, together with suitable pressure gauges and/or connections for testing the operation of the device.

2.24 WATER CONSUMER - The owner or person in charge of any building or premises supplied by or in any manner connected to a public water system.

2.25 WATER PURVEYOR - The person operating a public water supply.

2.26 WATER SERVICE LINE - A pipe or water line, with or without a meter and valves, whereby water is conveyed from the public water supply system to the initial point of use by the consumer.

2.27 VACUUM BREAKER DEVICE - A device consisting of a moveable disc or check valve and an atmospheric vent designed so that a pressure less than atmospheric in the supply line will open the vent and prevent backsiphonage.

SECTION 3.0 CROSS-CONNECTIONS

3.1 No person shall install or maintain a cross-connection between a public water supply system or service line connected to a public water supply system, and any other source whereby non-potable water or other contaminating substances may enter the public water supply system.

3.2 No person shall install or maintain a cross-connection between public water supply system or service line connected to a public water supply system and that of any auxiliary or other water supply unless such supply and the inter-connection have been approved in writing by both the purveyor and the Division of Sanitary Engineering.

3.3 The water purveyor shall not install a water service connection to any premises where a violation of Sections 3.1 or 3.2 of these regulations exists.

3.4 The water purveyor shall discontinue, after written notice to the occupants, water service to any premises where a cross-connection or unauthorized connection to an auxiliary supply exists or where required backflow prevention devices have not been installed or have been removed or by-passed, or where the water purveyor, Health Officer, or Division of Sanitary Engineering is denied entry to confirm compliance with these Regulations. Water service to the premises shall not be restored until the deficiencies have been corrected.

3.5 No person shall install or maintain any cross-connection between any water supply system serving a public use facility or business establishment and any non potable source whereby non potable water may be dispensed to or be used by the general public.

3.6 Where an investigation by the Division of Sanitary Engineering, Health Officer, or purveyor discloses that a cross-connection exists, the owner or person occupying or having charge of the premises where such cross-connection exists, shall remove such cross connection or install an approved backflow prevention device as directed by the Health Officer or Division of Sanitary Engineering.

SECTION 4.0 WHERE PROTECTION IS REQUIRED

4.1 An approved backflow prevention device shall be installed on each service line to a premises where, the Health Officer or the Division of Sanitary Engineering has determined that a potential or actual health hazard or other degradation of the public water supply exists.

4.2 An approved backflow prevention device shall be installed on each service line serving, but not necessarily limited to, the following types of facilities unless investigation by the Division of Sanitary Engineering determines that no potential or actual health hazard or other degradation of the public water supply exists.

4.2.1 Hospitals, mortuaries, clinics, nursing homes, animal hospitals;

4.2.2 Laboratories;

4.2.3 Sewage treatment plants, sewage pumping stations, storm water pumping stations;

4.2.4 Chemical plants, dyeing plants, metal plating industries, tanneries;

4.2.5 Petroleum processing or storage plants;

4.2.6 Slaughterhouses, poultry processing plants, food or beverage processing plants;

4.2.7 Piers, docks, waterfront facilities;

4.2.8 Photo development plants;

4.2.9 Car washes, laundermats;

4.2.10 Public swimming pools;

4.2.11 Farms where the water is used for other than household purposes;

4.2.12 Other facilities specified by the Division of Sanitary Engineering.

4.3 An approved backflow prevention device shall be installed on each service line serving premises where any of the following conditions exist:

4.3.1 Premises having internal cross-connections that, in the judgement of the water purveyor, Health Officer, or the Division of Sanitary Engineering, are not correctable or having intricate plumbing arrangements which make it impractical to determine whether or not cross-connections exist;

4.3.2 Premises where, because of security requirements or other prohibitions or restrictions, it is impossible or impractical to make a cross-connection survey;

4.3.3 Premises having a repeated history of cross-connections being established or re-established;

4.3.4 Others specified by the Division of Sanitary Engineering.

4.4 An approved backflow prevention device shall be installed to isolate the following systems or facilities, from potable or public water supply systems unless the Division of Sanitary Engineering determines that no health hazard to the public water supply system exists. Such installation may be required regardless of other protective devices required by these regulations.

4.4.1 Lawn sprinkler systems, irrigation systems;

4.4.2 Fire service systems;

4.4.3 Laboratory facilities.

SECTION 5.0 TYPE OF PROTECTION REQUIRED

5.1 The type of protection required under these Regulations shall depend on the degree of hazard which exists or may exist as determined by the Division of Sanitary Engineering.

5.1.1 An approved air gap separation shall be installed where, in the judgement of the Division of Sanitary Engineering, a public water supply may be contaminated with substances that could cause a severe health hazard.

5.1.2 An approved air gap separation or an approved reduced pressure principle backflow prevention device shall be installed where in the judgement of the purveyor or the Division of Sanitary Engineering, a public water supply may be contaminated with any substance that could cause a health hazard.

5.1.3 An approved air gap separation or an approved reduced pressure principle backflow prevention device or an approved double check valve assembly shall be installed where in the judgement of the purveyor or the Division of Sanitary Engineering, a public water supply may be contaminated with any substance that could degrade the water quality or adversely affect the public water supply system.

5.1.4 An approved non removable vacuum breaker device or barometric loop may be installed where the degree of hazard is low and where backflow can occur by backsiphonage only. Such installation shall be as close as practical to the potential contaminating source.

5.1.5 Barometric loops or vacuum breakers are not acceptable as backflow prevention devices where backflow due to back pressure may occur.

5.2 An approved air gap separation or an approved interchangeable connection with a non removable reduced pressure backflow prevention device shall be installed at any point of connection between a public water supply and any auxiliary water supply not approved by the purveyor and the Division of Sanitary Engineering.

5.3 Any booster pump installed within a premises served by a public water supply or on the service line to such premises shall be equipped with a check valve on the discharge line and low pressure cut-off designed to shut-off the booster pump when the pressure in the service line on the suction side of the pump drops to twenty-five (25) pounds per square inch gauge (129.25 cm Hg) or less, unless it is determined by the Division of Sanitary Engineering that an adequate supply exists to prevent the creation of a negative pressure in the service line.

5.4 Pumping stations within the public water supply distribution system shall be equipped with a low pressure cut-off designed to shut off the booster pump when the pressure in the distribution line on the suction side of the pump drops to twenty-five (25) pounds per square inch (129.25 cm Hg) or less, unless it is determined by the Division of Sanitary Engineering that an adequate supply exists to prevent the creation of a negative pressure in the distribution system.

5.5 The requirements of Section 7.4 shall apply to the low pressure cut-off device.

5.6 At premises where backflow prevention devices are required by this regulation and the public interest requires continuous uninterrupted service, two approved backflow prevention devices shall be installed in parallel and properly valved to permit continuous operation, or service to the premises shall be from two separate service lines protected by approved backflow prevention devices.

SECTION 6.0 BACKFLOW PREVENTION DEVICES

6.1 Any backflow prevention device required by these Regulations shall be installed at a location and in such manner as to facilitate testing and servicing and at a location and in a manner approved by the purveyor and the Division of Sanitary Engineering.

6.2 Any backflow prevention device required by these Regulations shall be purchased, installed, maintained, and tested by, and at the expense of the consumer except as provided for in Section 6.3.

6.3 Nothing in these Regulations shall prohibit the purveyor from installing or testing backflow prevention devices at his own expense or prohibit mutual agreement between the purveyor and the consumer for such installation.

6.4 When any backflow prevention device required by these Regulations is found to be defective, the consumer shall immediately notify the purveyor and the Division of Sanitary Engineering of such defect and shall at his own expense within ten (10) days repair, replace, or overhaul such device.

SECTION 7.0 PLANS, SURVEYS, INVESTIGATIONS, AND TESTING

7.1 Where backflow prevention or other devices are required by these regulations the consumer shall provide the Division of Sanitary Engineering any drawings, plans, specifications and other data required to insure compliance with these regulations.

7.2 The water purveyor shall establish a cross-connection and backflow prevention program acceptable to the Division of Sanitary Engineering and consistent with the extent of the public water supply system.

7.3 On request by the water purveyor, or the Division of Sanitary Engineering the water consumer shall furnish the water purveyor information on water use practices and facilities within the consumer's premises in-

cluding plumbing diagrams, drawings, or plans as required.

7.4 The water consumer on any premises on which backflow prevention devices required by these regulations are installed, shall have inspections and operational tests made of the devices at intervals and in a manner as required by the water purveyor or the Division of Sanitary Engineering. Inspections and tests shall be at the expense of the water consumer and shall be performed by a person certified by the Division of Sanitary Engineering as qualified to inspect and test backflow prevention devices. Records of all inspections and tests shall be provided to the water purveyor.

7.5 The water purveyor shall maintain records of all inspections, surveys, tests and corrective actions taken. Records shall be maintained for a period of at least two years and shall be furnished upon request to the Division of Sanitary Engineering.

7.6 The water purveyor and authorized representatives of the Health Officer or the Division of Sanitary Engineering shall have the right to enter premises served by the public water supply,except private dwellings, at all reasonable times for the purpose of making surveys and investigations of water use practices within the premises.

7.7 Where new water service connections are being furnished to private dwellings formerly served by individual wells, or to dwellings where there is reason to believe that cross-connections exist, the purveyor shall request permission to inspect the premises to determine if violations of these regulations may exist. Water service shall not be provided until such inspection is made and violations corrected.

7.8 No provision of these regulations shall relieve the water consumer of the responsibility for conducting surveys of water use practices on his premises to determine whether there are actual or potential cross-connections.

7.9 Activities required by these regulations shall be in accordance with all applicable guidelines and design standards contained in the Division of Sanitary Engineering Bulletin, EW-114, "Cross-Connection and Backflow Prevention Manual".

SECTION 8.0 PROHIBITED DEVICES

No person shall install, maintain, sell, or distribute for sale any device of a type which has been determined by the Division of Sanitary Engineering to contain actual or potential cross-connections.

SECTION 9.0 REPEAL OF FORMER REGULATIONS

All regulations previously adopted by the West Virginia State Board of Health, which are in conflict with the provisions of these regulations are hereby repealed.

SECTION 10.0 SEVERABILITY

Each section of these regulations and every part of each Section is an independent Section and a part of a Section, and the holding of any Section or part thereof to be unconstitutional, void, or ineffective for any cause does not affect the validity or constitutionality of any other Section or part thereof.

SECTION 11.0 PENALTIES

Any person who violates any provision of these regulations or any regulation adopted by the West Virginia State Board of Health pursuant to the authority granted by these regulations shall be guilty of a misdemeanor and shall upon conviction be punished by a fine of not more than $200.00 or by imprisonment for not more than 30 days or both fine and imprisonment as provided in Chapter 16, Article 1, Section 20 of the Public Health Laws of West Virginia, West Virginia Code. Each day's failure to comply with any applicable provision of these regulations shall constitute a separate offense.

SECTION 12.0 CERTIFICATION AND FILING OF THE REGULATIONS

I hereby certify that the foregoing regulations constitute the official regulations adopted by the State Board of Health on January 21, 1976, and filed pursuant to law in the office of Secretary of State, State of West Virginia.

N.H. Dyer, M.D., M.P.H.
State Director of Health

Acknowledgement, that the above regulations were filed with the Office of Secretary of State on 2/13/76.

James R. McCartney
Secretary of State

FILED IN THE OFFICE OF
SECRETARY OF STATE OF
West Virginia

THIS DATE FEB 13 1976

George E. Pickett, M.D., M.P.H.
Director

State of West Virginia
DEPARTMENT OF HEALTH
CHARLESTON 25305

September 21, 1978

M E M O R A N D U M

TO: CONSULTING ENGINEERS AND ARCHITECTS, PUBLIC WATER SUPPLY PERSONNEL, AND HEALTH DEPARTMENT STAFF

FROM: CROSS CONNECTION PROGRAM

RE: REQUIRED BACKFLOW PREVENTION DEVICES

Section 4.0 of the CROSS CONNECTION AND BACKFLOW PREVENTION REGULATIONS requires that backflow prevention devices be installed in certain specific circumstances, or when it is determined by this office that a hazard to the water system exists. Section 5.0 requires that the type of device be determined by the degree of hazard or risk to the system. The following general principles are to be followed in determining the type of backflow prevention device required:

1. A REDUCED PRESSURE BACKFLOW PREVENTER shall be installed where Section 4.0 requires a backflow prevention device on the major service line to a facility, except as provided in items 2 and 3 below.

2. Where investigation by this office, including review of plumbing plans for the premises, reveals that no actual or potential hazard exists, a DOUBLE CHECK VALVE ASSEMBLY* may be approved in lieu of a REDUCED PRESSURE DEVICE. Such approval shall not be granted routinely, but only where unusual conditions warrant.

3. Service lines supplying fire sprinkler systems only, must be protected by a minimum of two approved CHECK VALVES. One of these CHECK VALVES may be the ALARM CHECK provided as part of the sprinkler system. The other may be a DETECTOR CHECK, DOUBLE CHECK VALVE ASSEMBLY, or an approved SINGLE CHECK VALVE. Specific questions regarding requirements or instalation procedures should be referred to this office.

4. For internal protection (to isolate certain systems, facilities, or fixtures from the remainder of the premises) VACUUM BREAKERS may be used if the connection is not subject to back pressure.

   A. If an ATMOSPHERIC TYPE VACUUM BREAKER is used it must be located on the discharge side of the last valve on the line serving the fixture or equipment and placed at least six inches above the highest outlet.

   B. VACUUM BREAKERS may be used to isolate lawn sprinklers or irrigation systems. If an ATMOSPHERIC TYPE BREAKER is used, it must be installed at least 12 inches above the highest sprinkler head.

   C. Where a valve must be located on the discharge side of the VACUUM BREAKER or where the VACUUM BREAKER cannot be placed the required distance above the outlet, a PRESSURE TYPE VACUUM BREAKER must be used.

5. For internal protection where back pressure may occure, a REDUCED PRESSURE DEVICE will normally be required. In some instances a DOUBLE CHECK VALVE ASSEMBLY WITH INTERMEDIATE ATMOSPHERIC VENT will be acceptable. Prior approval for the use of a DOUBLE CHECK VALVE ASSEMBLY must be obtained from this office.

   A. A REDUCED PRESSURE DEVICE will be required on boiler feed lines.

   B. A REDUCED PRESSURE DEVICE must be used to isolate all laboratories from the remainder of the premises.

6. All backflow prevention devices required by the Regulations must be of a type approved by this office. Listings of approved devices are published periodically by the Drinking Water Program.

*A DOUBLE CHECK VALVE ASSEMBLY is an integral device designed specifically for backflow prevention. Two SINGLE CHECK VALVES in series are not equivalent to, or acceptable in lieu of, a DOUBLE CHECK VALVE ASSEMBLY.